

Remarks

Claims 1-10 are pending herein. Claim 8 has been withdrawn as being directed to a non-elected invention. By this Amendment, claims 1, 2, 4, 6, 7 and 10 have been amended, and claims 11-13 have been canceled.

Claim 1 has been amended in part to recite that the hafnium organic compound vapor and the silane-series gas are supplied simultaneously into the reaction vessel. Support for the amendment to claim 1 can be found in the specification at, e.g., page 9, lines 17-27.

Claim 1 has been further amended to recite that the hafnium silicate film is deposited on the substrate by a chemical vapor deposition process. Support for this recitation can be found in the specification at, e.g., page 3, line 13.

Claim 2 has been amended to recite that the heated atmosphere is established in the interior of the reaction vessel when depositing the hafnium silicate film. Support for amended claim 2 can be found in the specification at, e.g., page 9, lines 10-11.

Claim 4 has been amended to include the contents of canceled claim 11.

Claim 6 has been amended to include the contents of canceled claim 12.

Claim 7 has been amended to recite that the step of depositing the silicon hafnium film includes the step of supplying simultaneously a vapor of a hafnium organic compound and a silane-series gas into a reaction vessel to react the hafnium organic compound and the silane-series gas with each other in the reaction vessel, thereby depositing the hafnium silicate film on the substrate by a chemical vapor deposition. Support for the amendments to claim 7 can be found in the specification at, e.g., page 3, line 13 and page 9, lines 17-27.

Claim 10 has been amended to include the contents of canceled claim 13.

In the Office Action, claims 1-5, 7, 9 and 11 are rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent Application Publication No. 2004/0025787 to Selbrede; and claims 6, 10, 12 and 13 are rejected under 35 U.S.C. §103(a) as being unpatentable over Selbrede in view of U.S. Patent Application Publication No. 2003/0104706 to Mitsuhashi.

In view of the amendments and remarks herein, Applicants respectfully request reconsideration and withdrawal of the rejections set forth in the Office Action.

I. Rejection Under 35 U.S.C. 102(b)

Claims 1-5, 7, 9 and 11 are rejected under §102(b) as being anticipated by Selbrede.

Applicants respectfully submit that claims 1-5, 7 and 9 are not anticipated by Selbrede.

Claim 11 has been canceled.

(A) Claims 1-3 and 9

As noted above, claim 1 has been amended in part to recite that the hafnium organic compound vapor and the silane-series gas are supplied simultaneously into the reaction vessel. Thus, claim 1 is directed to a film forming method comprising supplying simultaneously a vapor of a hafnium organic compound and a silane-series gas into a reaction vessel to react the hafnium organic compound and the silane-series gas with each other in the reaction vessel, thereby depositing a hafnium silicate film on a substrate by chemical vapor deposition. Claims 2, 3 and 9 depend directly or indirectly upon claim 1.

As to claim 1, Selbrede is cited in the Office Action for teaching a film forming method comprising reacting a hafnium organic compound and a silane-series gas in a reaction vessel, thereby depositing a hafnium silicate film on a substrate (paragraph [0064] and Figure 3). Paragraph [0064] of Selbrede states the following:

Alternatively, the first gas precursor film can also be deposited to a specific thickness (one or multiple reaction cycles), followed by the second gas precursor film to another specific thickness (one or multiple reaction cycles), thus building a "stacked" structure of films. For example, a laminate of HfO₂ and SiO₂ could be created by using hafnium (IV) t-butoxide as the first gas precursor and silane as the second gas precursor, which after annealing, can produce a hafnium silicate film. Another example is the formation of a laminate of HfO₂ and Al₂O₃ by using hafnium (IV) t-butoxide as the first gas precursor and aluminum ethoxide as the second gas precursor, which after annealing, can produce a hafnium aluminate film. Further, another example is the formation of a hafnium-silicon-nitrogen-oxygen film by using appropriate multiple precursors and other process conditions. [emphasis added]

Thus, in paragraph [0064], Selbrede teaches a laminate composed of two separately deposited precursor films, one of the films being HfO_2 and the other film being SiO_2 . A hafnium silicate film is formed after annealing the laminate.

On the other hand, in the film forming method of claims 1-3, the hafnium organic compound vapor and the silane-series gas are supplied simultaneously into the reaction vessel and are reacted with each other in the reaction vessel, thereby depositing a hafnium silicate film on the substrate.

The instant specification teaches that:

After the interior of the reaction vessel is stabilized at the predetermined process temperature, tetra-tertiary-butoxy hafnium in a liquid state is fed from the liquid source supplying source 41, the flow rate thereof being adjusted by the liquid massflow controller 43 to a predetermined flow rate (e.g., 0.02 sccm to 1 sccm). Thereafter, the liquid tetra-tertiary-butoxy hafnium is fed to the vaporizer 44, is vaporized by the vaporizer 44, and the vapor is supplied into the reaction tube 1. Disilane gas whose flow rate is adjusted by the massflow controller 53 to a predetermined flow rate (e.g., 50 sccm to 1,000 sccm) is supplied into the reaction tube 1 through the second gas-supplying pipe 5. The pressure in the reaction tube 1 is adjusted by the pressure adjusting device 14 to a predetermined reduced pressure, for example, 26.6 Pa to 133 Pa (0.2 Torr to 1.0 Torr). Thus, the tetra-tertiary-butoxy hafnium and the disilane gas are thermally decomposed in the reaction tube 1, and a film containing hafnium, oxygen, and silicon, i.e., a hafnium silicate film is deposited on the wafer W. [emphasis added] (page 9, lines 10-27).

Selbrede does not teach or suggest simultaneously supplying a vapor of a hafnium organic compound and a silane-series gas into a reaction vessel to react the hafnium organic compound and the silane-series gas with each other to directly form a hafnium silicate film by a chemical vapor deposition process. Instead, Selbrede teaches only that a laminate of different films is first formed and the laminate is then converted into a single film. Furthermore, Selbrede teaches that the HfO_2 and SiO_2 films therein are typically formed by an ALD process that

alternatively supplies the applicable precursor (i.e., hafnium (IV) t-butoxide for the HfO₂ film and silane for the SiO₂ film) and an oxidizer.

Thus, for at least the foregoing reason, Applicants respectfully submit that Selbrede does not anticipate instant claims 1-3.

(B) Claims 4, 5 and 7

Claim 4 has been amended to include the contents of canceled claim 11. Thus, claim 4 is directed to a film forming method comprising depositing a hafnium silicate film on a substrate and annealing the deposited hafnium silicate film in an atmosphere of a compound gas of nitrogen and hydrogen. Claims 5 and 7 depend upon claim 4.

Claim 7 has been amended to recite that the step of depositing the silicon hafnium film includes the step of supplying simultaneously a vapor of a hafnium organic compound and a silane-series gas into a reaction vessel to react the hafnium organic compound and the silane-series gas with each other in the reaction vessel.

As to claim 4, Selbrede is cited for disclosing depositing a hafnium compound film containing hafnium and oxygen on a substrate, and annealing the deposited hafnium compound film in an atmosphere of a compound gas of nitrogen and hydrogen (paragraphs [0064] and [0065]). As to claim 7, Selbrede is cited for disclosing that the hafnium compound is a hafnium silicate film deposited by reacting a hafnium organic compound and a silane-series gas (paragraph [0064]).

Paragraph [0064] was reproduced previously herein. Paragraph [0065] of Selbrede is reproduced below:

The deposition of laminate films, such as described above, can be subsequently followed by appropriate thermal processing such that a "new" film can be produced with properties different from either the laminate film or the laminate constituents themselves. *For example, a "new" hafnium silicate film could be formed by thermally annealing a laminate of hafnium oxide and silicon oxide.* Further, a laminate of HfO₂ and HfON films could be formed by using hafnium (IV) t-butoxide and NH₃, which after annealing, produces a hafnium oxynitride film. It is also noted that a laminate can be formed using a system of the present invention in

conjunction with other conventional techniques, such as ALD, MOCVD, or other techniques. [emphasis added]

In both paragraphs [0064] and [0065], Selbrede teaches a laminate composed of two separately deposited precursor films, one of the films being HfO_2 and the other film being SiO_2 , and forming a hafnium silicate film by annealing the laminate. Selbrede does not teach or suggest simultaneously supplying a vapor of a hafnium organic compound and a silane-series gas into a reaction vessel to react the hafnium organic compound and the silane-series gas with each other to directly form a hafnium silicate film by a chemical vapor deposition process. As pointed out previously herein, Selbrede teaches only that a laminate of different films is first formed and the laminate is then converted into a single film.

Thus, for at least the foregoing reason, Applicants respectfully submit that Selbrede does not anticipate instant claims 4, 5 and 7.

II. Rejection Under 35 U.S.C. 103(a)

Claims 6, 10, 12 and 13 are rejected under §103(a) as being unpatentable over Selbrede in view of Mitsuhashi.

Applicants respectfully submit that claims 6 and 10 would not have been obvious over Selbrede in view of Mitsuhashi. Claims 12 and 13 have been canceled.

Claims 6 and 10 depend directly or indirectly upon claim 4. Claim 6 has been amended to include the contents of canceled claim 12, and claim 10 has been amended to include the contents of canceled claim 13. Thus, claim 6 is directed to the method of claim 4, further comprising depositing a silicon nitride film directly on the hafnium silicate film after the annealing of the hafnium silicate film. Claim 10 is directed to the method of claim 5, further comprising depositing a silicon nitride film directly on the hafnium silicate film after the annealing of the hafnium silicate film.

Selbrede is cited in this rejection for the reasons given above. According to the Office Action, Selbrede does not teach depositing a silicon nitride film after the annealing of the hafnium compound film. Mitsuhashi is cited for teaching a method for depositing a silicon nitride film after the annealing of the hafnium compound film (paragraphs [0056] and [0057]).

Instant claims 6 and 10 both have been amended to recite that the silicon nitride film is deposited directly on the hafnium silicate film after the annealing of the hafnium silicate film. At paragraph [0056], Mitsuhashi teaches that a polysilicon film 24 is interposed between a silicon nitride film and an HfO₂ film 23. Mitsuhashi does not teach or suggest depositing a silicon nitride film directly on a hafnium silicate film after the annealing of the hafnium silicate film.

Therefore, for at least the foregoing reason, Applicants respectfully submit that claims 6 and 10 would not have been obvious over Selbrede in view of Mitsuhashi.

III. Conclusion

In view of the amendments and remarks herein, Applicants respectfully request that the rejections set forth in the Office Action be withdrawn and that claims 1-7, 9 and 10 be allowed.

If any additional fees under 37 C.F.R. §§1.16 or 1.17 are due in connection with this filing, please charge the fees to Deposit Account No. 02-4300; Order No. 033082.283.

Respectfully submitted,

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